

Baseline assessment of irrigation system

at Isis - Bundaberg area Aug 2021

Baseline data for an irrigation system provides the basis for all discussions and assessments of possible improvements for the system.

Background information

This soft hose water winch irrigator is supplied from a SunWater-controlled pressurised outlet with an electric booster pump providing the required flow and pressure. The type of system is a typical design for the irrigation of sugarcane in the Isis district, southern Queensland.

The system usually irrigates 18.37 ha, however, in some seasons it is required to irrigate up to 27.98 ha. The irrigation system includes the following components:

- The pump is a 100x65-250 (264 mm impeller) direct drive by 45 kW 2-pole CMG electric motor (2940 RPM rated). The WEG variable speed control has two set points.
- The mainline pipe is 155 mm (6") AC (asbestos cement) with 100 mm (4") Southern Cross style hydrant outlets at multiple distances and elevations from the booster pump. Hydrants are 560 to 2700 m from the pump.
- The water winch is a 4" Avokah turbine drive soft hose irrigator fitted with 200 m (10 chain) of 102 mm (4") Waterlord layflat hose and a Nelson Big Gun spray fitted with a 37.08 mm (1.46") ring nozzle.



Recent upgrades:

The farm operator recently upgraded the size of the flow meter and replaced the pump with a secondhand, later model pump. A VFD (Variable Frequency Drive) with the option of two different pressure set points has also been installed.

What we did

An irrigation assessment was carried out to establish critical baseline performance criteria for the following:

<p>DSC (Design System Capacity) or mm/day of irrigation that can be applied in 24 hours.</p>	<p>?</p> <p>Can the system meet the crop water requirement?</p>
<p>MSC (Managed System Capacity) or mm/day of irrigation that can be applied in normal practice considering the PUR (Pump utilisation ratio).</p>	<p>?</p> <p>Can the system meet the crop water requirement under management conditions and application efficiency conditions?</p>
<p>kW.h/ML (kilowatt hours of energy consumed by the system to apply a megalitre (ML) of water).</p>	<p>?</p> <p>How does the energy cost comparison to theoretical use and pumping energy industry benchmarks?</p>
<p>kW.h/ML/m (kilowatt hours of energy consumed by the system for every 1 m of head pressure to apply a megalitre (ML) of water).</p>	<p>?</p> <p>How does the performance of the pump and motor compare to industry benchmarks?</p>

Data collection and processing:

STEPS:

- 1 **An electronic pressure gauge was used** to measure the inlet and outlet pressures of the pump when it was operating. To ensure accuracy, the gauge was tested against a calibrated device.
- 2 **The flow rate was measured** using three methods (for verification):
 1. the SunWater permanent installed meter (Seimens MagFlo),
 2. a portable Ultra-Sonic meter and
 3. against the operating pressure of the Nelson Big Gun nozzle.
- 3 **Electricity consumption was measured** using the energy service provider meter. Start and end readings were taken over a measured time interval.
- 4 **The data was processed** using the **CaneCalcs** web application. The **CaneCalcs** app was developed for the project to support local technical service providers and farmers. The app provides a quick analysis of performance with the ability to compare against similar systems. The app output highlights any disparity between the user's system performance and industry benchmarks, prompting the user to investigate options for system improvement.

If the app analysis showed abnormal performance outcomes, more detail analysis would be done with careful manual calculations.



What we found

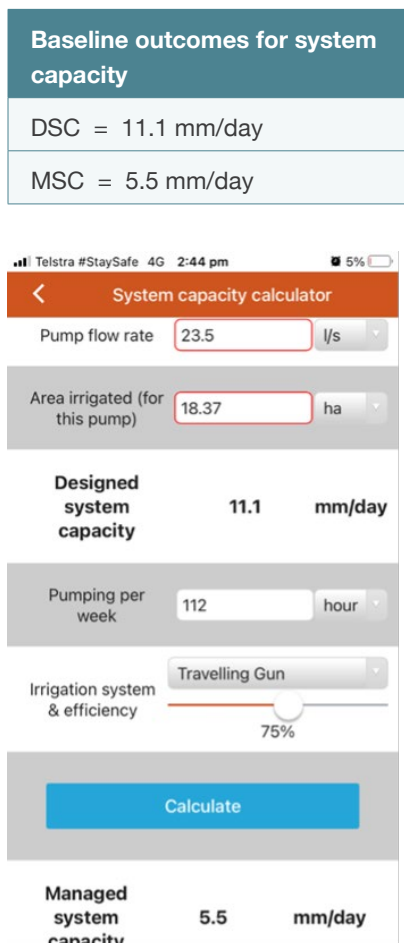


Figure 1 CaneCalcs app system capacity

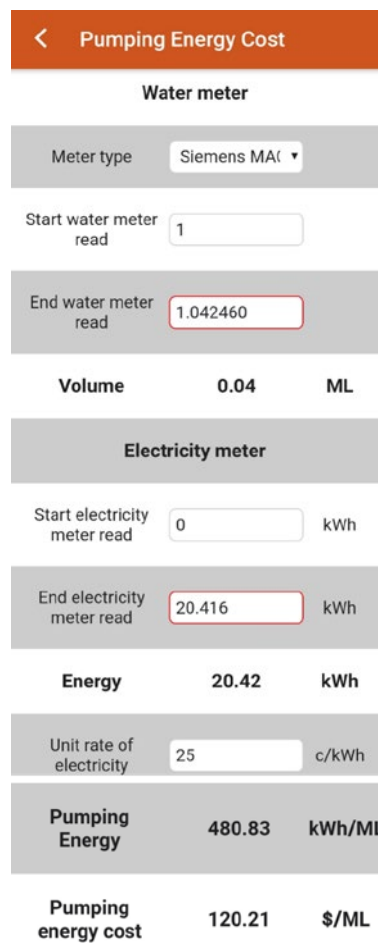
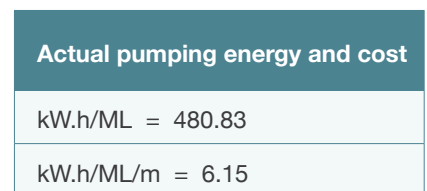


Figure 2 CaneCalcs app pumping energy cost



The **CaneCalcs** app does not calculate pump performance directly. Performance is simply the kWh/ML divided by the TDH (Total Dynamic Head) or the inlet and outlet pressure combined (positive discharge pressure less the positive inlet pressure when pumping).

The benchmark for this type of pump system is 4 kWh/ML/m, which would mean the kWh/ML should be 312.73 kWh/ML, or \$78.18 per ML.

This pump is costing \$120.21 per ML to operate, therefore the user could save up to \$42.03 per ML if the pump performance were improved.



CaneCalcs available in any web browser at: canecalcs.com

Recommendations

The following table shows the potential payback and return on investment if an upgrade to the pump was implemented.

Simple Return on Investment if you implemented pump changes for the existing winch system:

Upgrade	Cost to implement	Saving kWh	Savings @ \$0.25	Payback period years	ROI %
Pump & Motor	12,400	16810	4,202	2.9	33.9

**Based on 100 ML volume of irrigation applied.*

Hydraulic loss calculations carried out indicated an extra 10 m of head is being consumed in the delivery system when operating the travelling gun at the tested position. There is good reason to suspect that this unexplained loss could be greater in other travelling gun positions on the farm.

The most likely cause is a blockage in the pipeline due to a buildup of sediment. With the current pump the additional energy consumption is costing \$15.37 per ML. Fixing this loss would reduce the required pressure at the pump by 10 m (14.2 PSI).

The following table shows the cost benefit of solving the loss with the current pump and with an upgraded pump:

Implement change	Cost to implement	Saving kWh	Savings @ \$0.25	Payback period years	ROI %
Fix hydraulic loss with existing pump	\$1,000	6150	1,537	0.65	153
Fix hydraulic loss plus Pump & Motor upgrade	\$13,400	20810	5,202	2.6	38.8

**Based on 100 ML volume of irrigation applied.*

In addition to saving pumping costs, these upgrades should result in higher managed system capacity (MSC) through increased pressure at the travelling gun nozzle, which will result in a higher application rate for the same energy consumption.

If the same number of irrigations were applied with the travelling gun the potential yield increase could be 3.7 t per ha x 18.37 ha = 68 t of cane @ \$40 t, earning an extra \$2720 for no increase in energy cost.

The following table shows the effect of yield increase, fixing hydraulic loss and pump upgrade:

Implement change	Cost to implement	Saving kWh	Savings @ \$0.25	Payback period years	ROI %
Fix hydraulic loss plus Pump & Motor upgrade with yield increase 3.7 t/Ha	\$13,400	20810	7,922	1.7	59